The MBone: A New Paradigm for Globally Distributing Interactive Multimedia Sessions[1]

William E. Johnston[2]

Information and Computing Sciences Division

Ernest Orlando Lawrence

Berkeley National Laboratory

University of California
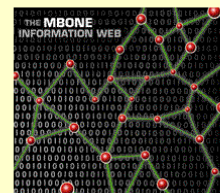

Our thesis is ......

MBone –– Communications for the Next Millennium

◙ MBONE WINS '95 R&D 100 AWARD

In March 1992, a new venue quietly debuted on the Internet –– one in which people worldwide could meet in a common electronic window and not only see and talk to one another, but work on a shared "whiteboard." This conferencing network –– called the Multicast Backbone, or MBone –– has the potential to launch a new era in scientific collaboration.

Since its inception, MBone conferencing has grown exponentially, with traffic doubling about every eight months. Right now, more than 10,000 people in 30 countries are using it for collaborative work. "Among scientists," predicts Stewart Loken, who heads LBL's Information and Computing Sciences Division, "MBone conferencing will become as routine as e-mail. And this will

What is the MBone?

♦ **A Network Technology**

  • **IP multicast routing is a new capability that provides "interest" driven "broadcast", independent of location, and with the minimum possible bandwidth**

♦ **A Vehicle for Interactive Multimedia**

  • **MBone supports a collection of realtime, N-way, multimedia applications providing audio, video, and shared interaction tools**

♦ **A Sociological Phenomenon**

  • **multimedia programming to "targeted" global audiences**

  • **Every PC is a "transmitter" (regulation??)**

What is the MBone?

A Network Technology

♦ **Steve Deering [1], Xerox PARC (Stanford Ph.D. thesis: "Multicast Routing in a Datagram Network")**

♦ **Demand-driven, selective "broadcast" of IP datagrams**

  • **"bottom-up" route generation**

  • **dynamic pruning of routes**

♦ **Strong advantages over unicast or circuit oriented transmission for "broadcast"**

♦ **Implementation is a testament to the flexibility of the Internet**

What is the MBone?

A Vehicle for Interactive Multimedia

♦ **Van Jacobson and Steve McCanne, LBNL**

  • **R&D Magazine's 1995 R&D 100 Award for "development of a software toolpack that enables multiparty audio and visual conferencing via the MBone" [14]**

♦ **sd - session directory, announcement, and rendezvous [13]**

  • **the "TV Guide" - update via IP multicast**

♦ **vat - audio conferencing**

  • **audio control center**

  • **variable bandwidth**

  • **"floor" management**

What is the MBone? - Interactive Multimedia

♦ **vic - video conferencing tool [11]**

  • **video control**

  • **multiple video formats and devices**

  • **variable bandwidth**

♦ **wb - shared whiteboard**

  • **a multiparty, shared "drawing" surface**

♦ **All of these tools are symmetric: they are both the receiver and the transmitter**

♦ **Many other tools as well ..... (See [3])**

• **audio conference tools**
  - **Nevot - UMass**

• **video conference tools**
  - **NetVideo (Xerox PARC)**
  - **IVS (INRIA)**

• **JPEG Images**
  - **IMM - U. Hawaii**

• **point-to-point**
  - **Mmphone Rendezvous Software/Service**

• **multicast gateways**
  - **to CuSeeMe**

  - **to Maven**
  - **to Apple QuickTime Conferencing**
  - **format and bandwidth conversion [15]**

• **MBone VCR (record, store, and playback multimedia sessions) [23]**

• **commercial activity**
  - **tools**
  - **service providers**
    + **(lots - see [3])**
  - **workstations and network equipment**
    + **most major platforms support IP multicast**
    + **network routers also becoming IP multicast capable [3]**

What is the MBone?

A Sociological Phenomenon

◆ **Mbone provides the mechanism for delivering highly targeted programming**

In principle, a single content producer can supply a single customer, but more interestingly, can supply ten customers at ten different places in the world.

◆ **A single producer can have an audience of thousands, again, all over the world (not just in a "broadcast area")**

• **Mbone distribution of the NASA Select channel: "In Feb., 1994, 906 hosts from 12 countries (AU, BE, CH, DE, FI, FR, IT, NL, NO, SE, UK, US) watched live coverage of NASA's STS-60 shuttle mission" [16]**

What is the MBone? - Sociology

• **"Project Jason (the Monterey Bay Aquarium and Naval Post Graduate School collaboration to provide live coverage of the Jason sea-floor explorer to schools" (See [17])**

◆ **Mbone is fully symmetrical**

Anyone can be a producer, and the consumer and producer look exactly the same to each other. This feature is used today to provide conferencing and interactive participation in seminars, workshops, etc.

♦ **So .... what we have is a new paradigm, with many new ideas and capabilities**

MBone can provide (in principle) everything that commercial broadcasters do today (wide distribution of non-interactive media content), and much more at the same time (practical "individual" production, worldwide scope, interactivity, multiple media, etc.)

• **Insoft / Netscape: "collaborative computing, desktop conferencing, and distributed digital video" [7]**

" ... eleven technology-leading companies announced plans to support Netscape LiveMedia, which is based on open standards and interfaces that will enable Netscape and third-party real-time audio and video products to interoperate. Companies that announced their support are Progressive Networks, Adobe Systems, Digital Equipment Corp., Macromedia, NetSpeak, OnLive!, Precept, Silicon Graphics, Inc., VDOnet, VocalTec and Xing. The Netscape LiveMedia framework will be based on the Internet Realtime Transport Protocol (RTP), RFC number 1889, and other open audio and video standards ... "

• **Xing's Live and On-Demand Audio/Video Server [24]**

"100 CD's - *LIVE* From Pentagon Records"

"WBBR - Bloomberg Information News Radio - LIVE from New York!"

"Live Radio and TV Programming from Finland"

"VORTEX Live and Professor Neon's TV & Movie Mania"

"Live "World Radio Network" feed from Internet Multicasting Service"

"LIVE Video Broadcast - NBC Pro Financial News Channel"

• **Internet Phone**

♦ **Such a vision depends on widely available, high bandwidth IP networks**

   • **because the architecture seems well suited, there is a good chance that the existing cable TV infrastructure might provide an early realization of high speed networking to many homes, and this may be how the paradigm shift will start**

   • **a widely deployed fiber infrastructure can support the same capabilities provided that the telecomm industry pays considerable attention (i.e. as a first priority) to the IP aspects of the network**

What is the MBone? - Sociology

♦ **(I think) a well developed, widely deployed, IP data network could provide virtually all of our communication needs.**

  (Yes, including conventional telephony. See "VocalTec (Internet Phone) Announces Initial Public Offering of 2,500,000 Ordinary Shares February 7, 1996" [8])

Is the MBone going to obsolete TV transmitters and telephones?

◆ **Not anytime soon (MBone is still under active development), but . . . . . some very interesting things are happening**

◆ **Is audio, video, and whiteboard all that the MBone will distribute? (No)**

• **"World-Wide Web Caching", Martin Hamilton, Department of Computer Studies, Loughborough University of Technology - "This report investigates the applicability of a multicast approach to World-Wide Web object caching."[6]**
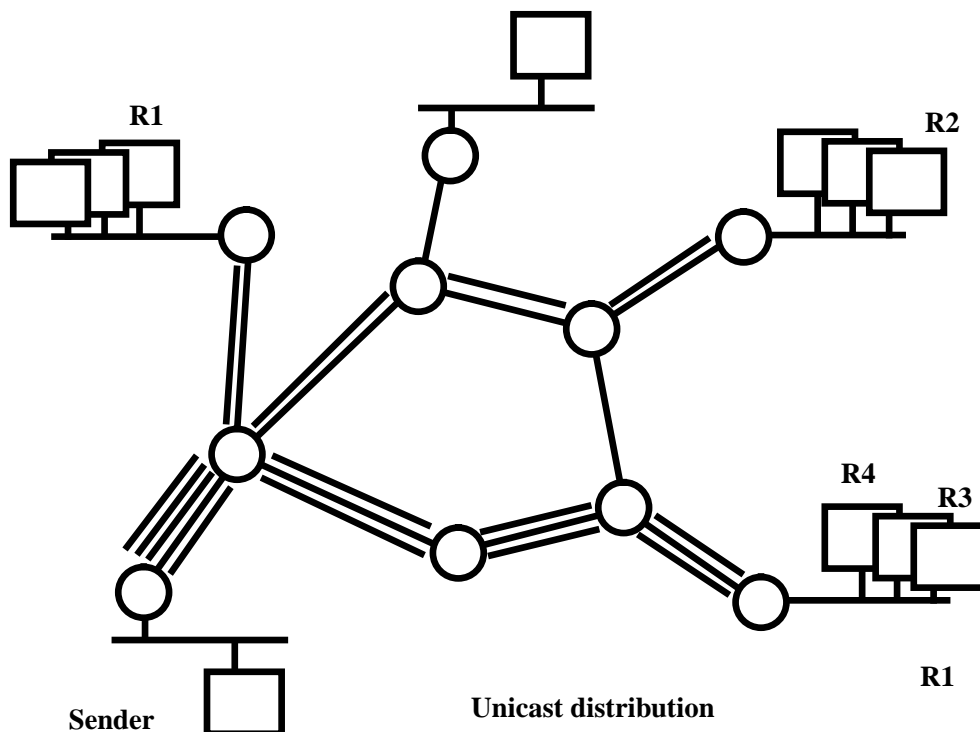
Some Underlying Technology

◆ **IP Multicast [12]**

  • **traditional view is that the sender thinks he can talk to all the receivers (so just dials them all up - like adding to a conference bridge) - problem is this one-to-many view**
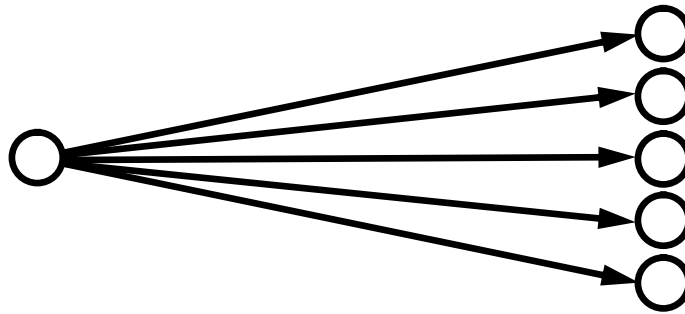
  when it really sits on top of a mesh topology network, and links may carry many copies of the conversation

Imaging and Distributed Computing Group,
Information and Computing Sciences Division
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[MBone.CommForum.fm - February 13, 1996]
LBNL

Some Underlying Technology

R1

R2

R4

R3

R1

Sender   **Unicast distribution**

Imaging and Distributed Computing Group,
Information and Computing Sciences Division
18
[MBone.CommForum.fm - February 13, 1996]
LBNL

Some Underlying Technology

• **MBone view is that: 1) the sender "talks to the wind", and gradually (if anyone is interested in listening) receivers announce their interest and, in return, get sent the conversation**
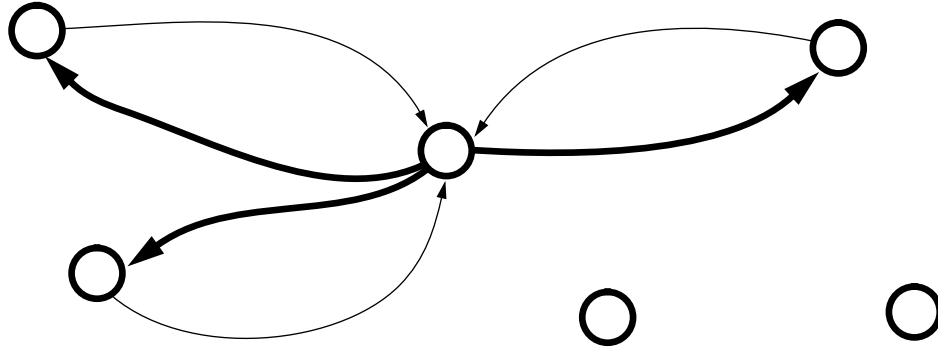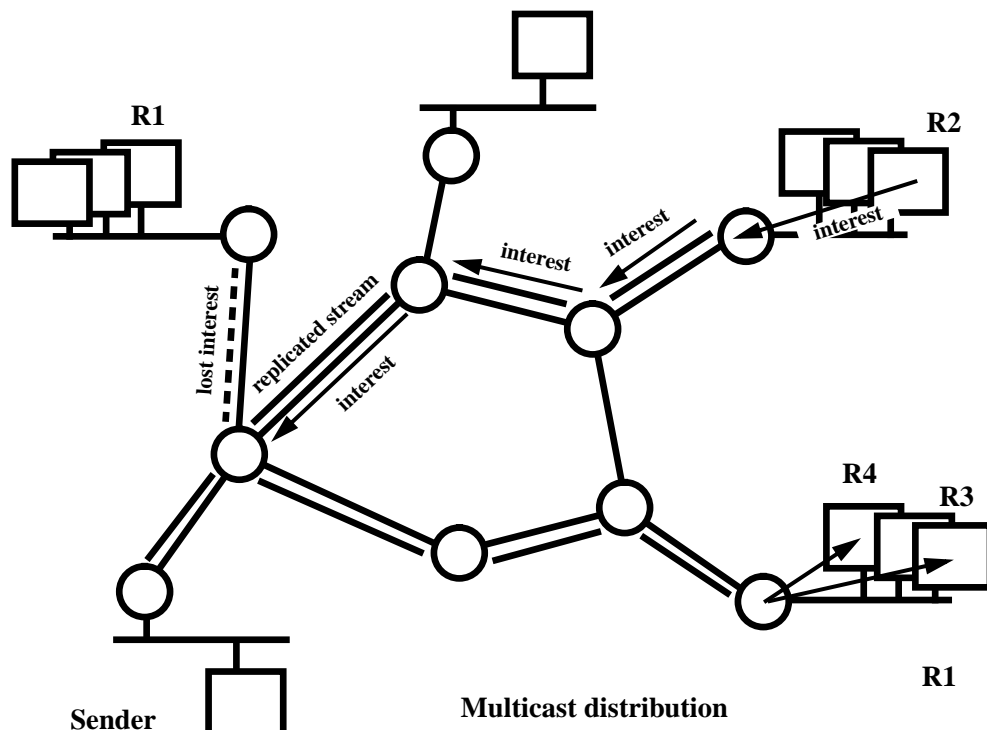
2) the underlying mesh network carries no more than one copy on each link (the routers only know the next router is "interested")

Some Underlying Technology

R1

R2

lost interest

replicated stream

interest

interest

interest

interest

interest

R4

R3

R1

Sender
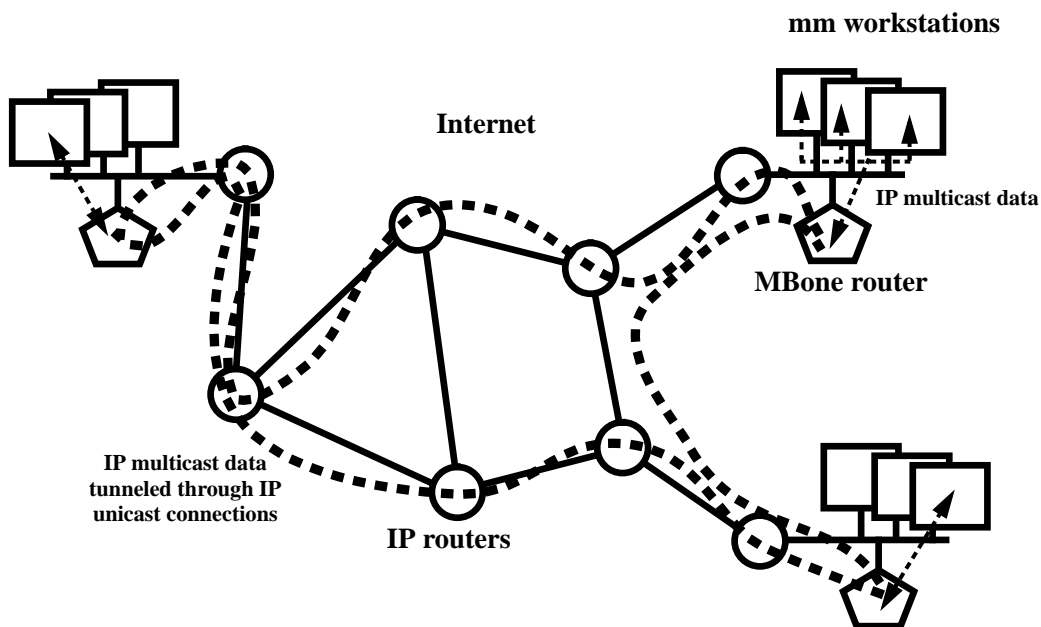
Multicast distribution

Some Underlying Technology

♦ **MBone as it exists "today"[2]**

- **Steve Deering and Steve Casner (USC/ISI)**

- **A collection of interconnected multicast routers running compatible routing protocols**

- **A new infrastructure? Yes and no. (It is all built on top of the Internet.)**

Some Underlying Technology

The MBONE "tunnels" through the Internet
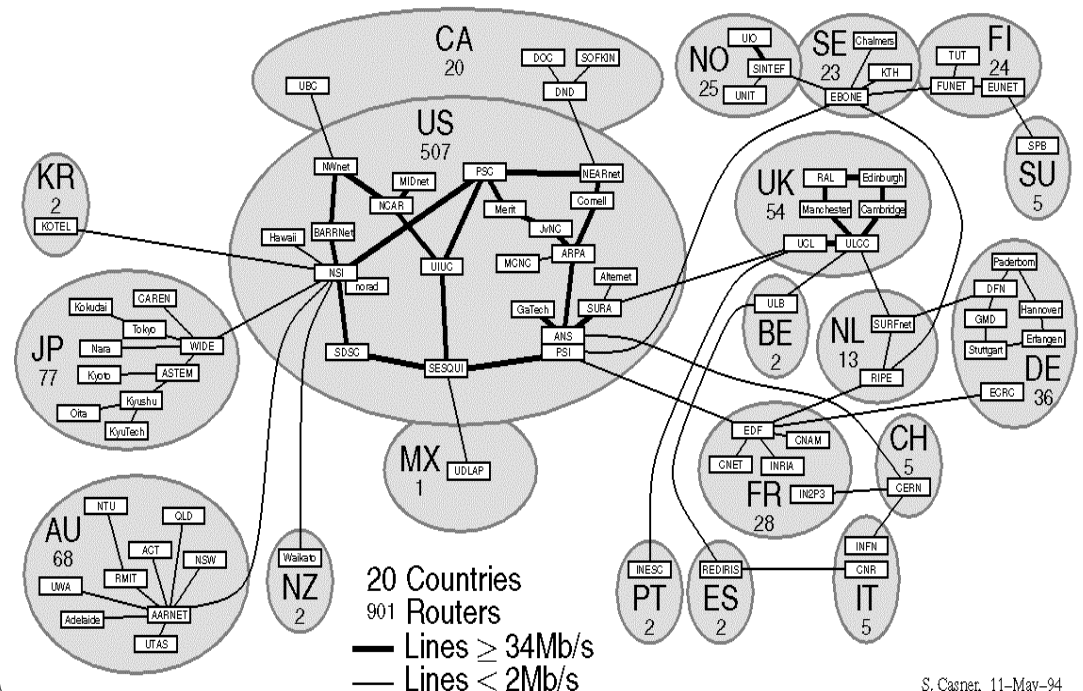
• **However, as commercial IP routers gain multicast capabilities, the tunnels just disappear (being replaced by native multicast routers) [18]**

• **Growth of the MBone is like the Internet - "exponential" [9]**
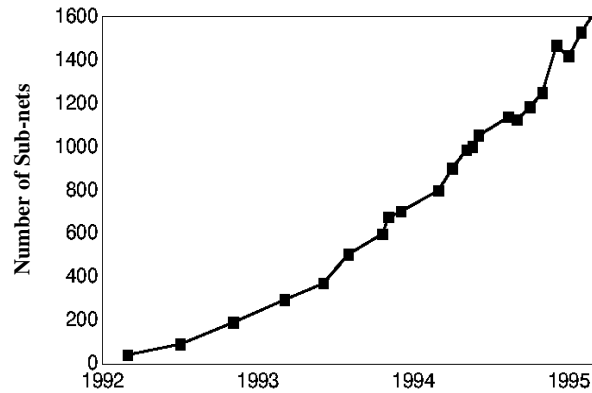
Major MBONE Routers and Links

20 Countries
901 Routers
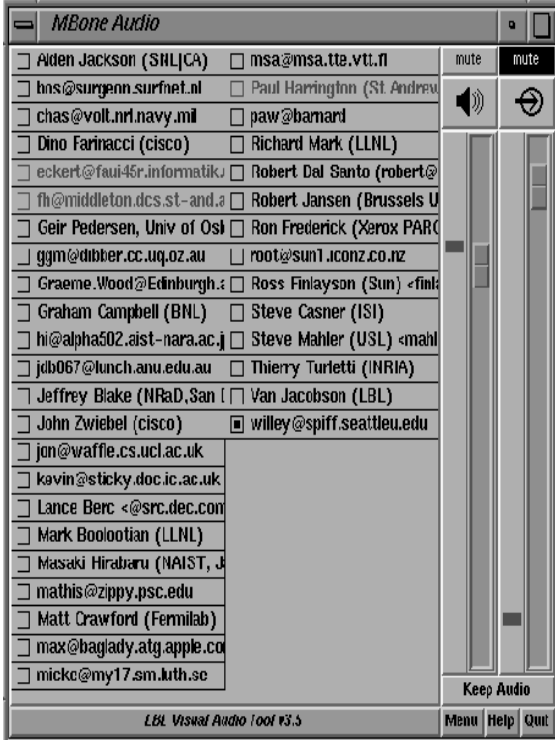—— Lines ≥ 34Mb/s
— Lines ≤ 2Mb/s

S. Casner, 11–May–94

Some Underlying Technology

◆ **Internet Real Time Protocol (RTP) is the transport service**

- **"RTP provides end-to-end network transport functions suitable for applications transmitting real-time data, such as audio, video or simulation data, over multicast or unicast network services." [19]**

- **to this we add standards specifically for video and audio [20]**

◆ **Gateways provide**

- **protocol conversion (e.g. to CUSeeMe)**

- **video format conversion (e.g. JPEG to H.261)**

- **bandwidth adjustment (e.g. adapting a 10 Mb/s motion JPEG stream to a CellB receiver on a 128 Kb/s ISDN-based network) (See [15])**

Some Underlying Technology

◆ **vat**

- **"Visual Audio Tool"**

- **supports N-way communication (everyone can both talk and listen)**

- **provides "floor management" (can see who is talking, etc.)**

- **works with audio hardware built into workstations**

Some Underlying Technology

Some Underlying Technology

◆ **vic [11]**

- **receives and originates video in several formats**

- **decodes video in software, reads video from many different capture cards**

- **accommodates a wide range of "quality" (and bandwidth)**

- **handles multiple video sessions**

Some Underlying Technology
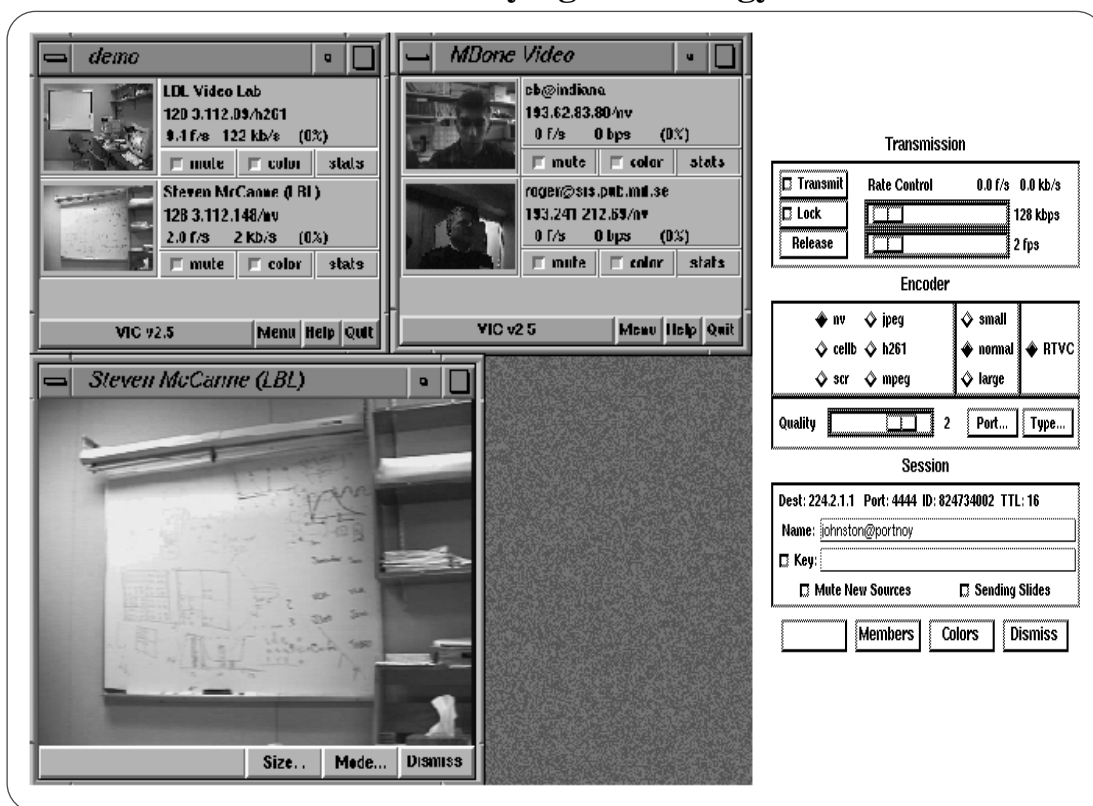
Some Underlying Technology

♦ **wb**

- **"Whiteboard" tool**

- **allows many people to draw on a shared window**

- **each "drawer" owns a distinct overlay "page", the collection of which can be "scrolled" through**

- **can import images and drawings**

- **uses a reliable multicast protocol [21]**

Some Underlying Technology
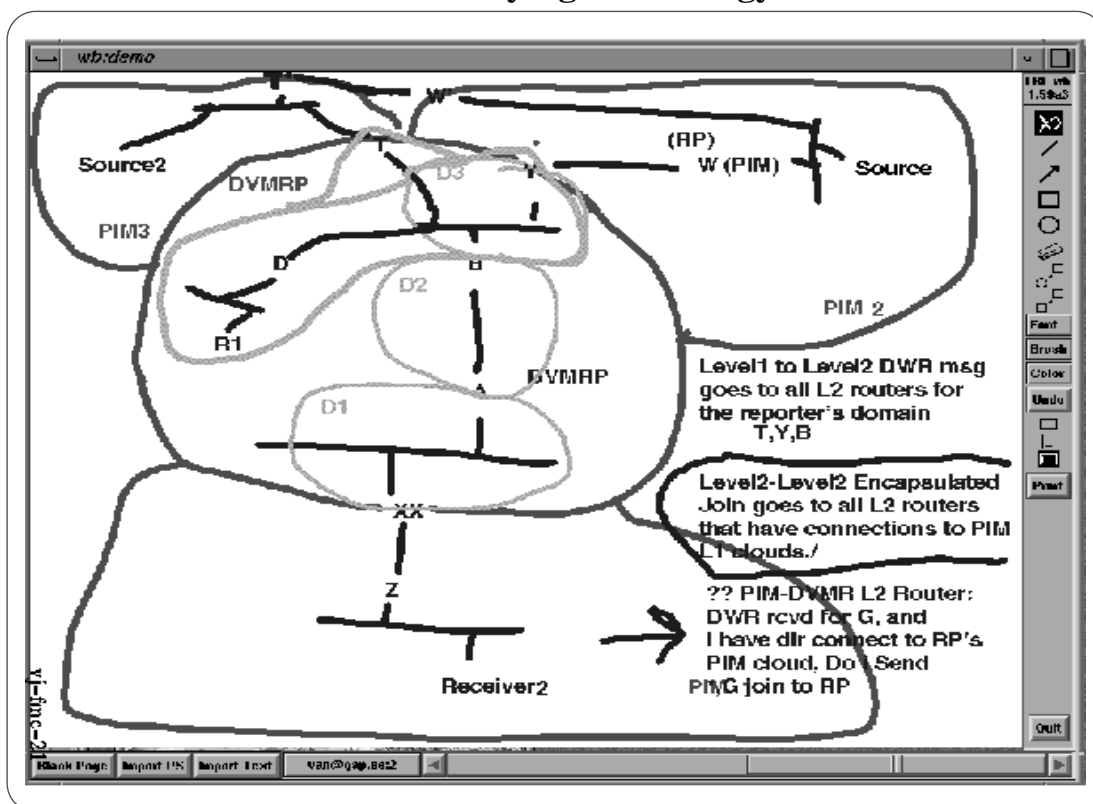
Some Underlying Technology

♦ **sd**

- **"Session directory" tool**

- **used for communicating information about the various multimedia streams of a session [13]**

- **originates this information**

- **communicates with other sd clients to build a directory of multimedia sessions all over the network**

Some Underlying Technology

sd

LBL Session Directory   v1.16
van@gap.ee.lbl.gov

FMC
Garrett QOS Talk (Audio, vat/PCM2)
Garrett QOS Talk (Video, vic/H.261)
Garrett QOS Talk (WB)
GMS–4 Composite
GMS–4 IR
GOES–7 IR 1
GOES–7 VIS
IMM astro–images
Journee–ROCAD
KQED

Future of Mathematical Communications
  URL http://www.msri.org/fmc next
  12/1/94 at 9am.
@ 224.2.189.27, ttl 127
Lifetime: from Wed Nov 30 12:30 PST
  until Sat Dec 03 12:30 PST
Media: audio@34479/59142,
  video@63746/23874,
  whiteboard@56881/1282

Open   New   Edit   Delete   Quit

sd

Name:
Description:

Address: 224.2.208.208
                        Port   ID

☑ Audio   59462   19400
☐ Video
☐ Whiteboard

Scope   Lifetime
◉ Site (31)   Starts: today
◇ Region (63)   at: 05:00
◇ World (127)   for: 2 hours
◇

Create ←   Cancel

MBone Sessions

A Random Sample of 1995 "Sessions" [22]

♦   California Superintendent of Schools Conference

♦ Board Aid and LifeBeat Aids Awareness Program
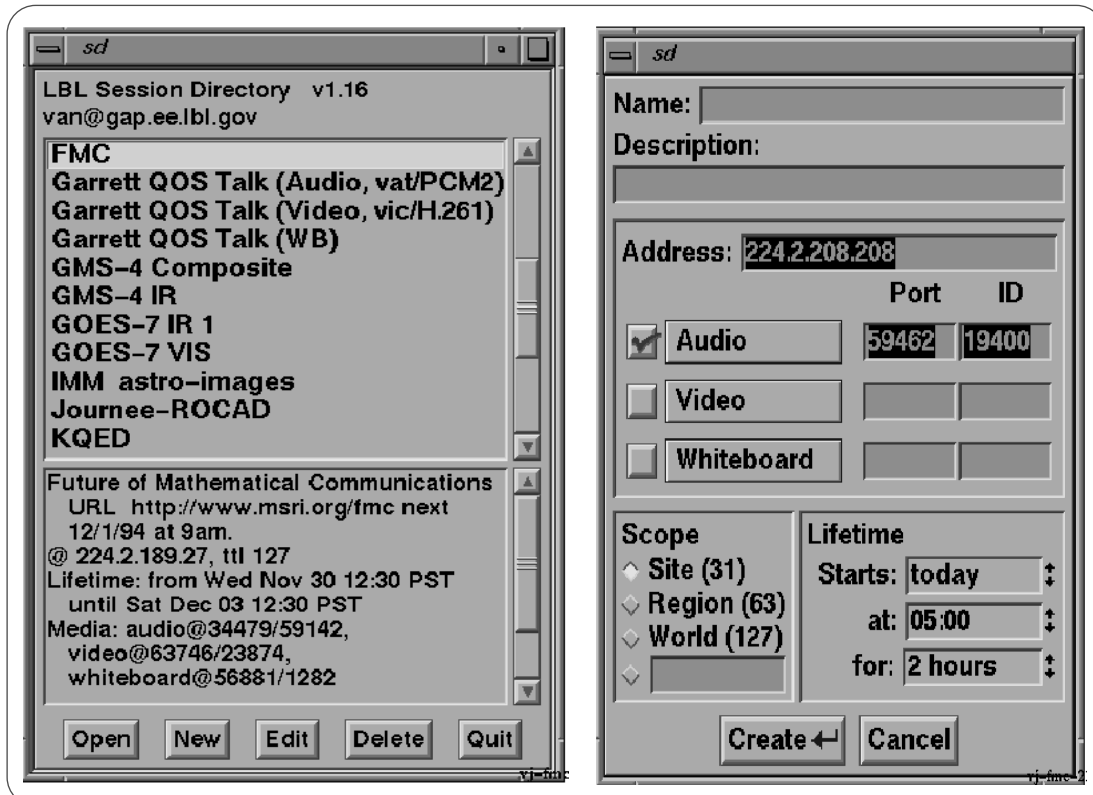
♦ UAM Workshop - Computer Based Tools to Assist in Air Quality (U.S. EPA)

♦ EMI Recording Artists "The Tea Party" perform live - Canadian Music Week

♦ **Private Conference (wb, video and audio). Keys distributed for the participants. (Private conferences are via encryption.)**

♦ Infocom'95 - IEEE Computer Communication Conference (from Germany)

♦ Second Workshop on Advanced Computing for Biological Imaging (U. Ill.)

♦ Opening Plenary JENC6 -Tel Aviv Israel

♦ Jacqueline F. Woods, Ameritech Ohio -- "Giving Consumers a Ch...

♦ Dynamo Open Air 1995 Hardrock festival (from Netherlands)

♦ Wrapped Reichstag Berlin - Press Conference

MBone Sessions

MBone Sessions

♦ **33rd Internet Engineering Task Force (IETF) Stockholm**

♦ **Computing in High Energy Physics (from Rio de Janeiro)**

♦ **Keynote Addresses from NETWORLD+INTEROP 95 in Atlanta**

♦ **Klapstuk '95 international festival on contemporary dance (from Belgium)**

♦ **Mid-Missouri Computer Art & Animation Festival**

♦ **Asia Pacific Music Festival (from Japan)**

♦ **Industrial Round Table: 'Managing the Unmanagable' (Hewlett-Packard Netherlands / Nijenrode University)**

♦ **Benefit Rock Concert from "The Mean Fiddler" in Dublin**

MBone Sessions

♦ **Prototype medical consultation and teaching project - University College, London**

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[2] Casner, S., et al, "Frequently Asked Questions (FAQ) on the Multicast Backbone (MBONE)." http://www.research.att.com/mbone-faq.html

[3] Kumar, V., "The MBone Information Web" http://www.mbone.com/techinfo/mbone.html

[4] "Computers and Internet:Multimedia:MBONE" (Yahoo) http://www.yahoo.com/Computers/Multimedia/MBONE/

[5] http://www.slac.stanford.edu/comp/net/video.html

[6] http://gizmo.lut.ac.uk/~martin/wwwcac/wwwcac.html

[7] http://www.insoft.com

[8] http://www.vocaltec.com/

[9] Casner, S. "Getting on the MBone: Video Conferencing over the Internet" ftp://ftp.isi.edu/mbone/nluug-slides.ps.Z

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[12]Jacobson, V., "Collaborative Work on the Internet (viewgraphs)." Conference on Future of Mathematical Communications, MSRI, Berkeley CA, December 1 1994. (http://ee.lbl.gov/nrg-talks.html)

[13]Handley, M., and Jacobson, V., "SDP: Session Description Protocol." Internet draft: draft-ietf-mmusic-sdp-00.{txt,ps}, working draft, 3/26/95. There is also version-01. (See: http://ee.lbl.gov/nrg-other.html)

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    See: http://www.lbl.gov/~gloria/mbone/currents.html

[15]Amir, E., McCanne, S., and Zhang, H., "An Application-level Video Gateway." To appear in ACM Multimedia
    '95. (See: http://ee.lbl.gov/nrg-papers.html)

[16]ftp://ftp.isi.edu/mbone/nasa-sts60-list.txt

[17]ftp://taurus.cs.nps.navy.mil/pub/mbmg/mbone.html

[18] Kumar, V., "MBone Router & Switching Equipment." See: http://www.mbone.com/techinfo/routers.html

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    net Draft, RFC-1889. (See: ftp://ds.internic.net/rfc/rfc1889.txt)

[20]Schulzrinne, H., "RTP Profile for Audio and Video Conferences with Minimal Control." Internet Draft,
    RFC-1890. (See: ftp://ds.internic.net/rfc/rfc1890.txt)

[21]Floyd, S., V. Jacobson, C. Liu, S. McCanne, and L. Zhang, "A Reliable Multicast Framework for Light-weight
    Sessions and Application Level Framing." Submitted to IEEE/ACM Transactions on Networking. An earlier
    version of this paper appeared in ACM SIGCOMM 95, August 1995, pp. 342-356.
        See: http://ee.lbl.gov/nrg-papers.html

[22]"The MBone Session Agenda" http://www.cilea.it/MBone/agenda.html

[23]"The MBone VCR Page" http://www.icsi.berkeley.edu/mbone-vcr

[24] http://www.xingtech.com/